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EDITORS' OUTLOOK

THE outlook for the universal acceptance of the metric system is very encouraging. The effort which is being made by medical, pharmaceutical, scientific, and engineering societies to adopt this system wherever possible, should prompt us as teachers to do all we can to secure its adequate teaching in our schools, so that when our young men and women go out to take up their life work in the various industries, they will not only be better fitted for their work but will be anxious to further its adoption where necessary. Many teachers have promised to buy pure chemicals and apparatus on metric specifications. Are we living up to our agreement? We cannot expect the Apparatus and Chemical Companies to send us our orders in metric units if we persist in using the English system. Let us make the small effort which it will cost us to help forward this simplified system of standards. When we view what benefit this universal adoption of the metric system will mean to all future scientific work, it makes the effort required for such adoption seem trivial. Let it be said there are no "slackers" among the teachers in this most important movement.

N. E. G.

THE future seems to promise much in the way of improved nomenclature in chemistry. The points which Dr. Sy made regarding the loose or wrong use of chemical terms in his paper "A Plea for a Pedagogical Scrapheap in Chemistry" in the February issue of THIS JOURNAL have already been given a hearty approval by some teachers. It is expected that many other comments will be forthcoming. Comments and criticisms lose much of their value unless they are turned into constructive channels.

For the benefit of those teachers who wish to do their part in helping forward this standardization work to which Dr. Sy's paper must give an impetus, I would call to their attention the work being done by the American Chemical Society's Committee on Nomenclature, Spelling and Pronunciation, under the chairmanship of Dr. E. J. Crane, Ohio State University, Columbus, Ohio. If you have any definite ideas on improving chemical nomenclature send them to E. J. Crane. He will welcome such suggestions.

W. SEGERBLOM

THE Washington report on a "Standard Minimum High School Course in Chemistry" is being put in tune with the criticisms which it has received from the teachers since the Milwaukee Meeting. These criticisms covering a national scope give promise of a most satisfactory outline. Come and take part in its adoption. The date is April 25th, 9–10 o'clock.

N. E. G.

ONE has only to read the radio programs in our daily newspapers to realize the great possibilities which radio offers in chemical education. The Minnesota Section of the American Chemical Society just demonstrated its usefulness in a series of lectures which were given to help forward the great Prize Essay Contest. Will the time come when we will have fewer and better lectures, or will the personality always be necessary in the lecture halls? Mr. Killeffer's article in this issue should help us to get the proper perspective of radio potentialities in chemical education.

N. E. G.

CHEMICAL EDUCATION VIA RADIO*

D. H. KILLEFFER, ASSOCIATE EDITOR, INDUSTRIAL & ENGINEERING CHEMISTRY, NEW YORK, N. Y.

For the purpose of the present discussion, education may be considered to be of two distinct kinds, each with its own objects and each with its own methods. The education of the class-room has very definite characteristics and is primarily directed to the training of the mind and the teaching of principles rather than the imparting of definite information. As distinct from this type of direct teaching, which requires the segregation of those receiving instruction into more or less definite groups, according to their abilities to learn, there is still another type of education which aims at the instruction of comparatively large, unsegregated groups of people to a definite idea or ideas. This second type of education is represented by our newspapers, magazines, advertising, and most recently by the wireless telephone. It is with this last phase we shall deal here.

Within the past two or three years the development of the radio telephone has been extremely rapid in this country. It has literally swept the country and converted hundreds of thousands of people to nightly listeners to the programs which are broadcasted from more than five hundred broadcasting stations scattered throughout this country and Canada. On this account, the value of the ether waves as a medium for the dissemination of information has become almost inestimable. Teachers, politicians, preachers, lecturers, musicians, advertisers, and indeed everyone who might conceivably be benefited by general publicity have used this medium at one time or another, and the results achieved as well as the continued interest of the audience attest the success of this new means of education.

In the early days of the wireless telegraph, before the art had developed to the point where the transmission of speech was practicable, it was realized that the principal draw back to its use to replace telegraph lines was the impossibility of directing the radiated waves toward any definite point and the consequent lack of any possible privacy. From the transmitting station ether waves radiate in all directions with nearly, if not quite, uniform intensity, so that any properly tuned receiving instrument within their range could pick them up with equal ease. This original disadvantage has become the keynote of the present system of radio broadcasting, for the fact that the ether waves carrying sound waves can be received with equal ease by every listener-in makes possible audiences larger than had ever before been dreamed of.

So far it has been impossible to place even an approximate estimate on

* Read before the Section of Chemical Education at the Milwaukee Meeting of the American Chemical Society, Sept. 10, 1923.

the number of listeners reached by any single broadcast program or by all combined. However, it is conservative to say that the number of receiving stations in this country runs into the many hundreds of thousands if not actually into the millions. One of the large broadcasting stations in New York has received appreciations of its programs at frequent intervals from Southern Florida and California, another is well known and liked by listeners in England, and it has been estimated that the three major broadcasting stations in New York receive an average of more than a thousand messages a day from their audiences.

The equipment necessary for a transmitter is both complicated and expensive, and has the additional disadvantage of rather strict legal restrictions. Many enthusiasts have them for their personal use, but the most powerful of the telephone stations are those operated by the Radio Corporation, the Bell System, various newspapers, hotels, theatres, department stores, and the like for advertising purposes. The receiving equipment is quite a different story. No legal restrictions interfere with their use and their construction is so simple that few Boy Scouts have not built their own. One may spend as much or as little as one likes on a set, from five dollars or less into the thousands for some of the most complicated receivers in period designed cabinets. Perhaps the ruling motive with most fans is that once possessed of receiving sets, they get "something for nothing," as no method has yet been devised for forcing payment for the programs received.

But to get to the real point of this paper. Here exists on one hand an audience of nation wide, if not actually world wide extent ready and anxious to be amused and instructed by the things they can freely grasp from the ether. On the other hand there are more than five hundred transmitting stations whose effectiveness for their owners depends on supplying their audiences continuously with interesting and instructive programs. They are usually faced with the difficulty of keeping their programs going, and are eager for new material or new talent of any kind. The combination is ideal for the dissemination of anything that can be made interesting in the form of sound waves.

I am not just sure who first conceived the idea of broadcasting popular talks on chemical subjects nor when, but that is really not essential. The important thing is that the idea was conceived and has been put into wide successful practice. During the past year talks of the kind have been broadcast from Milwaukee, Chicago, Detroit, Pittsburgh, Schenectady and New York, to mention only a few. With those talks, delivered from the Westinghouse station in New York, the writer was intimate and will limit the discussion to them and the steps necessary to get them "on the air," as the expression is.

The first station to whom application was made for time to put on the

New York Section's talks was that of the American Telephone and Telegraph Co., the most powerful in the country. It was found that this station is operated as a toll station, that is, those who wish to broadcast material through it are required to pay $10 per minute for the privilege and the minimum period is ten minutes. That their clients find such an arrangement profitable is amply attested by the number of firms and individuals who use this service. That precluded the use of that station, but served to increase enthusiasm for the idea of putting across the series.

Calls upon other program managers showed that the first is the only station operated on a basis of direct payment. Others are run on the basis of their advertising value to their owners and the method of accomplishing this object is to provide interesting programs for their audiences. They make the one condition that their programs shall contain no direct advertising for anyone but themselves. In other words they will not permit the broadcasting of straight advertising matter. If it can be dressed up in such a way to the listeners, without permitting the selfish motives to show through, it becomes a different story.

The programs offered consist principally of music of one kind or another, plays or parts of plays, lectures, market reports, sport results and general news. The one requirement that is emphasized in all the material presented is broad general interest. Without that the value of the program is nothing on account of the fact that the audience can "walk out" without disturbance by a simple turning of a knob and the labor of the uninteresting entertainer is vain.

Finally a tentative series of engagements was made with the program manager of the Westinghouse station in New York. These were made with fear and trembling on the part of the manager that we might not interest his audience and were made with the idea that unless interest was shown at once the whole program would be called off. That the audience was interested in what chemists are doing was evidenced from the start by the responses which came in, and the program was extended to include ten talks. These talks were designed to show in general terms the service which the chemist has rendered particular industries. At the end of the series a request was received to continue the talks throughout the summer, but after thinking the thing over carefully it was decided that it would be better to reserve them until the Fall when both the condition of the atmosphere and that of the audience would be more favorable to them. The interest which followed this series extended even to England as evidenced by two editorials in *Chemical Age* (London).

The series as carried out consisted of ten talks, each complete in itself, dealing with the chemists' activities in dyes, medicine, petroleum, leather, rubber, foods and nutrition. They were written by experts in the particular fields, members of the New York Section, and along the broadest

popular lines. Just what this last means is hard to convey to most chemical men who are accustomed to think of their own subject in terms which few laymen understand. For instance, if one refers to the atomic structure of a molecule without giving an immediate understandable explanation, the audience is sure to turn to the jazz band or the low comedy at some other station which they can understand.

There are several points which should be borne in mind by the person who is to address the radio audience, the most important of which is undoubtedly INTEREST. One can talk about banana peels interestingly but one can also put an audience to sleep with a description of the adventures of Captain Kidd. The ease with which the radio audience can turn to something else makes it all the more imperative that the interest in the story one tells be continuously sustained. Just how this interest can be attained and how held is, of course, a matter for the individual to decide. Perhaps no audience in the world is more heterogeneous, and every trick of the trade must be used to hold it. As one program manager put it, "About the only thing one can say about the radio audience is that it belongs to the *genus homo*. Some of them belong to the *genus homo sapiens*." Responses to our program have shown interest from bankers, lawyers, school boys, boot blacks and housewives that could be identified and many others who could not. On this basis it is hardly to be expected that that favorite subject of all chemists, "Chemistry in the Kitchen," would merit half the consideration some of us would give it.

A second salient point is that each talk must be complete in itself, and as short as possible to be so. One is reminded of the saying of old Dr. Woodhouse that "no man could speak for more than five minutes on any subject without becoming dull." If one talks for more than fifteen minutes to such an audience on a subject that is not directly and vitally interesting to each member of it, one is not likely to know when the audience silently walks out by tuning in something else. Series of talks are generally welcome, but since it is not possible to arrange consecutive dates except under unusual circumstances closer together than once a week, each must be interesting of itself. If the audience gets part of an idea one week and misses the next part, it is hardly to be expected that they will show much interest in the third part two weeks later.

A third point is largely mechanical but quite as important as the other two. The speaker who would hold his audience must speak clearly and slowly. There is no point in raising the voice and every argument against it. The sensitive microphone to which one talks is set in violent vibration by shouting, too violent to permit the hearer to distinguish the tones. A clear deliberate enunciation such as one might use in reading to an audience, is most desirable. Of course one's gestures are lost on the inanimate microphone.

Another important point to consider in the preparation of a talk to be given *via* radio is that one has no visible audience to whom one can work up. Many public speakers do not realize how much they rely on their audiences for enthusiasm and invariably they feel keenly the lack of it in talking through the ether. This was well illustrated by one of the New York Section's talks when the speaker continued only with difficulty for lack of visible demonstrations from his hearers. The sensation of addressing an unseen audience whose presence does not make itself known in any way is most peculiar. The sole representative of the vast audience in the sound proof room where one hears only one's own voice is the unresponsive microphone. No one but the speaker and nothing but heavy draperies which kill the undesirable echo are to be seen. One is torn between the alternate idea that there is a great audience and that there is none, that one is the victim of some huge practical joke and that one is merely awaiting the executioner. It is somewhat like waiting for the extraction of a wisdom tooth and must be felt to be properly appreciated. All of this has been included here as a warning to those who would talk extemporaneously. There are very few things harder to do than that under the circumstances.

The interest which must be maintained in each talk has been emphasized. It is seldom possible to gauge the effect of one's remarks except by the letters of the listeners-in and these are not as plentiful as they were before the novelty of the thing wore off. In the early days of broadcasting the audiences responded generously to every program by letter, telephone and telegraph, but now they take the programs as very much a matter of course. The only way to assure oneself of response is to offer to give those who write in something. It need not be much, but "something for nothing" seems to be the motto on each radio outfit. In connection with our talk on "Chemistry and Medicine" we offered the audience copies of the little booklet published by the Chemical Foundation on "The Future Development and Progress of American Medicine in the Age of Chemistry," and we received dozens of responses. Our other talks seem to have been absorbed with hardly a quiver. About the only real encouragement was that of the officials of the station who told us that so long as we did not get letters of criticism and condemnation the audience must be satisfied. It is an interesting side light on the selfishness of our race.

These remarks have been set down here in the hope that our chemical educators might be interested in spreading their influence beyond the class room by this means to the entire nation. Broadcasting stations are in operation in almost every important city in the country. They must have programs and they are willing to take everything that will interest their audiences. With this in mind and with the intensely interesting

aspects of our science on which to base short talks, the moral is easy: "Go thou and do likewise."

A COLLEGE COURSE IN ANALYTICAL CHEMISTRY*

WILLIAM H. CHAPIN, OBERLIN COLLEGE, OBERLIN, O.

A College Course

As the title of my paper indicates, I am to suggest a course in analytical chemistry suitable for a college, not for a university or technical school. I make the distinction because I do not consider myself competent to speak for a type of school in which I have never taught, although I suspect the same pedagogical rules apply in all cases. A distinction is necessary also because in colleges the time allowed for analytical work is usually limited in a very decided way.

Aim of the Course

Practically all teachers will now agree, I think, that the college course in analytical chemistry is not intended to train our students to become analysts. In other words, analysis is not an *end*, but a *means* to an end. It should aim, I think, to broaden and deepen and systematize our knowledge of General Chemistry. It should impart skill and accuracy of manipulation and develop our powers of observation. Finally, it should enable us to identify substances and to determine constituents quantitatively,—this last because quantitative determination is nearly always necessary in the promotion of other more important work.

Qualitative Analysis

From what has been said it will at once be inferred that my course in Qualitative Analysis makes up a part of the course in *General Chemistry*. It will start at, or near, the beginning of the second semester and will occupy all the student's time, so far as the laboratory work is concerned, for the rest of the year.

The success of the course depends largely on what has preceded in the first semester. This work should have included the non-metals and their *acid ions*, ionization, something about equilibrium, normal and molar concentration, and naturally a little about a few metals.

I should begin the second semester's work with a class review of equivalent and molar weights, normal and molar solutions, and ionization.

* Read before the Section of Chemical Education at the New Haven Meeting of the American Chemical Society, April, 1923.

I should follow this with a simple development of the laws of equilibrium as applied to precipitation and solution, hydrolysis, and, say, common-ion effect. This will be largely a summary of what has already been given.

I should then begin in the laboratory a study of the metals and their ions, proceeding in the *order of the qualitative groups*, beginning with silver, not in the periodic order.

Just at this point many will differ with me. Many will prefer to keep the periodic order, and some will regard it as absolutely esesntial to keep the class and laboratory work together. With such an arrangement it seems impossible to give the course at all. The class work as arranged in all our texts will not reach the metals until about the spring vacation, and to defer the laboratory work on them until that time would simply preclude all possibility of giving the qualitative course at all. But the subject matter usually presented in the class-room on the metals is so different from that which *can* be presented in the laboratory that it does not seem to me to be of such vital importance to keep the two types of work together. Moreover, my plan involves constant reference from laboratory manual to text, and thus serves to bind the two together.

After the review work on equilibrium and the other topics mentioned, I should begin the work on the metals about the third week of the second semester.

I should study the metals group by group in the order indicated above. The order of procedure is about as follows:—

First, a study of the metals themselves and their *ionic reactions*, also dry tests (flame, closed tube, charcoal, and bead). This work will also include other experiments which have no analytical significance, such, for example, as the making of preparations, for we do not forget that this is a course in General Chemistry. In doing the ionic reactions the simple equilibrium relations will be constantly brought out. Without this these reactions are simply not explained, and so are of very much less value.

The second part of the study of the metals consists of analytical exercises intended to utilize the student's knowledge of the reactions. The student prepares his own mixtures, and has in this work to use all his knowledge of the different ions in order to obtain stable solutions. In some cases the salt he needs (*e. g.*, a nitrate) will purposely be left out of the list of reagents, and he must prepare it by action of the acid on, perhaps, the carbonate. It is just as important for a student to know how to get ions together into stable mixtures as to know how to separate them.

The methods of analysis are partly original and partly from a printed scheme. The former is by far the more valuable work, but it is also a good thing to have in mind a more or less fixed scheme to which one can at any time refer. These schemes of analysis should be simple, although accurate, not of the complicated, time-consuming sort.

No unknowns are given out at this stage of the work—these come later.

It is not possible in the time at my disposal to present examples of laboratory directions covering the reaction work, but one thing must be said: these directions must be explicit. It will not do to say "a small piece of" or "a few cc.," etc. The student has no background of experience to guide him in these things. "A small piece" might be a piece as large as a walnut. That would be a small piece of coal. And this leads me to say that successful laboratory directions cannot be written by any one who is not actively engaged in laboratory practice and teaching. Directions thus written will have to be supplemented by the actual teacher at a great expenditure of time; and these supplementary directions are seldom recorded or heeded by the student.

One of the most important factors in successful laboratory work is the careful keeping of a note book. Indeed I think this constitutes almost half the course. The teacher must insist that neat, accurate notes accompany each experiment. These notes must be taken in a permanent notebook and in their final form as soon as the data are obtained. The habit of writing notes on scraps of paper and afterwards copying them off in "better form" is pernicious. Proper entry of notes should be regarded as a part of every experiment, not a separate exercise.

It goes without saying that neatness and order should be insisted on from the first. Without this all quantitative work is sure to fail, and the student who is allowed to be sloppy and disorderly in qualitative work will surely carry the habit over into quantitative.

The following examples will give an idea of the sort of analytical work done. It should be remembered that the student prepares the mixtures mentioned, as he does in much of the reaction work. The examples presented relate to the Iron Group and the preceding groups:

"Make up mixtures containing the following ions, and then separate and identify as in Exercise 5. Keep in mind the fact that the directions in the manual are intended to apply to mixtures containing all the groups.

1. Al^{+++} and Fe^{+++}
   (a) Use tables
   (b) Use $Na_2S_2O_3$, boiling off the SO_2 evolved
2. Fe^{++}, Cr^{+++}, Al^{+++}
   Use tables
3. Ag^{+} and Fe^{+++}
   (a) Tables
   (b) Original method."

The criticism will probably be offered that students are not likely to do as well with known mixtures as with unknowns. In answer I may say that I have taught the course for four years in almost exactly the form above outlined, and I find no lack of interest. Moreover, the tendency

towards dishonesty and a blind following of rules is much less than where unknowns only are used. The proof of the pudding is the results obtained with the students.

After proceeding thus through the six groups of metals I have my students review the tests for the *acid ions*, including Cl^- Br^-, and I^-, ClO_3^-, ClO^-, NO_3^-, NO_2^-, $CO_2^=$, $C_2O_4^=$, $C_2H_3O_2^-$, $SO_4^=$, $SO_3^{\equiv}$, and $PO_4^{\equiv}$. This review is intended especially to bring out the distinguishing tests, and should emphasize the common very valuable tests of heating with sulphuric acid.

When the student has thus been over the metals and the acid ions, he is given *solid unknown substances* for identification. These are at first single pure substances, such as salts, oxides, hydroxides, metals, and simple minerals. The student first makes a series of preliminary tests with the blowpipe, sulphuric acid, etc. He then dissolves the substance, and finds the metal and acid radical in the usual ways. Some general directions must be given about getting these substances into solution, but in particular the student must rely on his own knowledge to aid him. Having identified the substance, he hands in a report showing what he has done. If his tests are too meager, even though he may report correctly, he is asked to make other more distinctive tests.

The student enjoys this work very much, for it never goes beyond his reach, and is never disappointing or monotonous.

As soon as a sufficient number of simple substances have been identified, mixtures are given out, if there is still time, and these may be made as complicated as the student's ability will warrant. Liquid unknowns are never used in any case.

The More Advanced Qualitative Courses

I do not recommend at all the teaching of the more advanced type of Qualitative Analysis which goes into great detail in the development and application of equilibrium relations. These relations cannot be thoroughly understood unless they are developed in the laboratory in a *quantitative* way. Great detail and thoroughness of presentation in the class-room will *not* take the place of this quantitative laboratory work. I have taught a course for several years which sought to do this, and the results I got certainly did not justify the great expenditure of time. According to my experience the course above outlined gives the student a better drill, and the more complete development of equilibrium relations can better be taught by use of direct quantitative experiments, not by use of qualitative analysis at all. With the simple course in Qualitative above outlined and a quantitative development of the laws of equilibrium such as we present in our second-year course, the individual can develop the more complicated Qualitative work himself if occasion ever arises, which is very doubtful.

Quantitative Analysis

Quantitative Analysis comes in the second year of our chemical program, and makes up a part of what we call "Second Year Chemistry." The aim here again is to teach General Chemistry, particularly general principles. Practically all the work of the year is quantitative, part of it on experiments with a purely theoretical trend, part of it on Quantitative Analysis proper. Taught in this way, the analytical work offers an opportunity to apply the principles and to develop technique and a knowledge of useful methods—that is, methods which are useful, not primarily as an end or a means of livelihood but as a means to the working out of other problems. This fine blending of the theoretical and the practical is absolutely indispensable. It is pitiful on the one hand to see a so-called "analytical chemist" who can make fifty determinations of carbon in steel in an hour but doesn't know when to substitute phenolphthalein for methyl orange and why: and it is pitiful on the other hand to see a so-called "high-brow" who can spread big mathematics over a blackboard, but who couldn't make a quantitative determination of zinc if his life depended on it.

The course in Quantitative Analysis I shall outline is just now in the process of development. I have taught it nearly through now for the first time, although the work of the last five years has been leading up to it. Naturally there are some changes I want to make; but in general it is giving exactly the results expected of it. The following is given in preparation for the analytical work:

During the first four weeks of the first semester my students are engaged with the theoretical Second-Year work, and due to lack of apparatus or otherwise they work in groups, performing a specified experiment each period. The assignments are usually short enough so that some time is left at the end of the period after notes are completed, etc. This time is utilized in a careful study of the *balance, and weighing.* The topics covered in this way are:

Necessary Conditions
The Balance Mechanism
The Zero Point
Sensibility
Weighing by Interpolation
Short Method of Weighing
Vacuum Correction
Correction for Inequality of Beam Arms
Calibration of Weights

Some may wonder how students with so little experience can get any calibration values which can possibly be of any use. In defence of the

method I may say that I have those assigned to any one balance do the work as independently as possible and then compare results. If discrepancies occur they are required to repeat the work until they agree. I have checked the weights over myself, so as to know approximately what the errors are; and, I find, my students really get very good results. Of course they get a deal of practice in accurate weighing also, and learn to have somewhat greater respect for a delicate piece of apparatus, which is quite as important.

The Quantitative Analysis proper begins with the ninth week of the semester, after our class-room and laboratory has covered the subjects of: The Gas Laws, Laws Governing Change of State, Molecular Weights, The Laws of Combination, Atomic Weights, Valence, and Calculations. The work given at this time is all gravimetric. This covers a period of seven weeks.

It should be noted that during this time the theoretical course is still proceeding in the class-room, until towards the end of the period, when time is taken to discuss the analytical work.

The determinations made are of a simple typical nature. What these are is not so important, of course, as the way they are taught, although the attempt is made to select determinations which give thorough application of principles and variety in manipulation. The gravimetric determinations I am using this year are as follows:

Iron in Iron Ore
Sulphur in a Sulphide Ore
Carbon Dioxide in Limestone
Calcium in Limestone
Copper and Zinc in Brass

It will be noted that the customary silver chloride determination is not in this list. This is due to the fact that both silver and chlorine determinations have already been made in the theoretical part under "Constant Composition," and "Multiple Proportions," and with just as great accuracy as is demanded in analytical work.

The determinations are all run in duplicate, of course. The stocks of minerals are all carefully powdered, so that it can be required, not alone that the duplicate analyses check, but that determinations made by different workers should also agree.

The printed material on each determination goes under three heads: (1) Outline, (2) Procedure, (3) Notes and Exercises.

Under *Outline* is given a short summary of the theory of the method. This is essential because it prepares the student to understand the relationship between the parts of the procedure, and thus tends to prevent the latter from becoming simply a cook-book recipe.

The *Procedure* is made quite detailed, and points of manipulation are carefully guarded.

The *Notes and Exercises* either give information about the procedures or, more often, refer to books and papers where the information can be found. (These books, by the way, are kept on a special shelf right in the laboratory.) Many of these Exercises take the form of questions, and involve matters of a theoretical nature already discussed, or under discussion, in the class-room. The emphasis on this interrelationship between the theoretical and the practical helps, not only the analytical work, but also the theoretical, for the average student thinks he is really "doing something" when he is analyzing things, and he sees that the theoretical knowledge really helps him in this "useful" work. A good proportion of the questions are put in the form of numerical problems, which give much needed practice in calculations. Care is taken to make these cover all such subjects as Atomic Weights, Molecular Weights, Molecular Volumes, Oxidation-reduction, etc.

These Questions and Exercises are, many of them, worked out while the chemical operations are going on, and in any case the student is *not* allowed to go on with the next determination until those relating to a given determination have been completed and O. K.'d. The solutions of these exercises go directly into the note-book along with the practical data and calculations.

The Volumetric work comes in the second semester beginning with the fourth week, and after the matters of Solubility, Concentration, Ionization, and Indicators have been studied in both class and laboratory, and while the study of Equilibrium is proceeding in the class-room. This, again, extends over a period of seven weeks, as does the gravimetric.

The first work done here is the calibration of the volumetric apparatus, the procedure being the common one of weighing the water content of the apparatus, and calculating the volume from the "apparent" weight, or in some cases, the converse of this. The method we use is a very simple one, and requires very little time.

The volumetric determinations are of the usual type, as follows:

Preparation of N/5 Hydrochloric Acid
Preparation of N/5 Sodium Hydroxide
Analysis of a Carbonate-hydroxide mixture
Percentage of Sulphuric Acid in a Solution
Standard Dichromate
Iron by the Dichromate Method
Standard Permanganate
Iron by the Permanganate Method
Manganese Dioxide in Pyrolusite

Standard Iodine Sol
Standard Thiosulphate
Arsenic and Copper in Paris Green

The directions include the three divisions noted under the gravimetric work, namely Outline, Procedure, and Notes and Exercises. At every step pains are taken to have the student use the knowledge he possesses—for example, his knowledge of indicators, of oxidation and reduction, and of equilibrium, Pains are taken also about the necessary calculations, the aim being to lead the student to the most *direct* and simple methods.

It should be noted that here also time is taken in the class-room for discussion of all the procedures and the exercises; and in the laboratory matters of note-book keeping and technique are carefully guarded. The instructor remains in the laboratory a great deal of the time, and shows the student again and again how he should take care of his apparatus and desk and how he should carry out his manipulations. No laboratory directions can take the place of this *personal contact*, and incidentally, it may be remarked, that students need not be expected to have any higher standards of excellence than they see exemplified in their teacher.

In addition to this elementary course in Quantitative just outlined, we give what we call advanced courses, of which our students majoring in chemistry may choose perhaps 2 or 3 semester-hours. It is not necessary to describe these since the method of teaching is the same as in the elementary course.

THE HIGH SCHOOL CHEMISTRY COURSE VERSUS THE COLLEGE REQUIREMENT

CHARLES H. STONE, ENGLISH HIGH SCHOOL, BOSTON, MASS.

If the first and only function of the high school were to prepare its pupils for college, there could be little argument as to the content of its chemistry course. It would only be necessary to follow the outline for chemistry instruction as given in the syllabus of the College Entrance Examination Board. No other course would need to be considered. The principal argument which might be advanced against the present syllabus would be that it is much too comprehensive and cannot be covered satisfactorily in the usual one-year high school, or preparatory school course, unless it be in some special school which devotes its attention exclusively to training a selected group of students for admission to college.

The difficulty in the high school of meeting the college requirement in chemistry might be somewhat reduced if it were possible to make separate classes for the college preparatory students. But this is feasible only in

the large-city high school where several hundred boys and girls may be taking the course in chemistry. It is absolutely out of the question in the average small school.

As a rule, the high school teacher is confronted with the proposition that ninety per cent of his pupils in chemistry are not preparing for college. Nevertheless, he must give college preparation for the benefit of the few who may be going to college, ignoring the legitimate demands of the major portion of the class who do not contemplate instruction in a higher institution. Knowing that he stands or falls, to a large degree, according to the rating of his pupils who take the college examinations, he is practically forced to give the routine course, however much it may be against his better judgment. The syllabus of the College Boards does not satisfactorily provide for the needs of the ninety per cent; it does not call for the presentation of such topics as the chemistry of agriculture, of the local industries, of household chemistry, of photography, of the automobile, and similar aspects of chemistry which make so strong an appeal to the interest of all pupils and which ought to be available for the non-college preparatory student especially, since he will have little other chance to acquire this information. If such instruction is suggested in the syllabus, there is little likelihood that it can be given in the school since it requires all of the time and more to meet the specified requirements. The teacher who can successfully meet all of the conditions laid down in the syllabus and still find time for instruction in the chemistry of the local industries, or such other special study as the environment of the school seems to warrant, is a marvel. His name should be inscribed on imperishable brass and proclaimed with the sound of the trumpet.

When it is remembered that the present requirement includes: a very comprehensive study of the occurrence, preparation, properties, and uses of the principal non-metallic elements and their compounds, together with considerable study of the metals and their compounds; a study of the principal laws of chemistry and a study of the prominent theories, some of which are pretty stiff stuff for the young student; a study of chemical problems of various types; some organic chemistry (with pressure now and then to include more); that it may include some portions of physical chemistry, such as osmotic pressure, depression of freezing points, etc.; that recent advances in chemical discovery and knowledge, and new applications of chemistry to industry and the problems of life are claiming a place in our recent text books, it will be realized that the teacher, with the handicaps of non-segregation and ninety per cent of non-college preparatory students, is expected to accomplish an almost impossible task in trying to impress all this material upon the minds of young people who are distracted as never before with all the complexities of our modern life. One is tempted to ask: Is such a requirement justifiable? Is it necessary?

There is a growing belief on the part of both high school teachers of chemistry, and of college instructors, that the demands for admission to the colleges have been and now are excessive; that the conditions laid down do not sufficiently recognize the just claims of the great body of high school students who do not contemplate a college course; that by making too large a demand upon the preparatory school, the college is defeating its own ends, since in striving to meet such requirements, the work in the high school must be done so rapidly and the ground covered so superficially that time for proper digestion and assimilation of the matter presented is not available. What can one expect, under the conditions, but mental indigestion?

College instructors often complain that students come to them from the high schools so poorly prepared that it is necessary to repeat in the freshman year practically the same course as that given in the high school. In some colleges no distinction is made between students entering with chemistry and those entering without. Both classes are expected to take the same course. Under such conditions, the freshman, who has had a high school course, feels that he has virtually been put back, since the work he has already done does not appear to have given him any advantage. He may feel that real effort is not necessary since he has been over the ground before; or he may feel discouraged, lose his interest, and fail, or "get by" with a very low mark, so low perhaps that he gives up any thought of continuing the subject further. In either of the two cases the result speaks for some revision of the conditions as they now exist.

It appears to the writer that the colleges might so alter the requirements as to make admission to the higher institution less formidable without impairing the real quality of the candidates for admission. Which is better, a comprehensive requirement poorly covered, or a less comprehensive, but definite, intensive requirement, in which the student is well grounded? It would appear that the latter would furnish a suitable basis or starting point. To this point the high school might bring its pupils with a reasonable degree of proficiency, and from this point the college class might proceed, breaking practically new ground, without the present practice of repetition, unless a few weeks of rapid review might be thought advisable. Such a course, much shortened as to the specific requirements, would provide opportunity in the high school for such specialized instruction in the chemistry of the local industries as the environment of the school and the needs of ninety per cent of its pupils seemed to justify.

Let us suppose a case. Assuming the average school year to have thirty-six weeks, let a certain definite fraction of that year, say two-thirds or three-fourths, be devoted to a very thorough study of the non-metals and their compounds; oxygen, hydrogen, water, the air, chlorine and hydrochloric acid, sulphur and its oxides, hydrogen sulphide and sul-

phuric acid, ammonia and nitric acid, neutralization, etc., together with thorough drill on valence, equations, and problems, with such study of the laws and theories related to the topics studied as shall serve to throw light upon them. Let this limited but intensive study be made the basis for the questions in part one of the examination. Let the preparation in this limited amount of ground be sufficiently thorough so that the college can proceed from that point without the necessity of repetition.

Let the remaining fraction of the year be devoted to specialized work in some such manner as this:—

1.—A study of certain selected metals; their occurrence, metallurgy, properties, uses, compounds. The chemistry of the common alloys, automobile steels, and the local foundry are topics that might be included.

or 2.—A study of the chemistry of the local industries; agriculture, including soils, fertilizers, and insecticides; paper and pulp; textiles and dyeing; leather; or whatever the local industry may be.

or 3.—The chemistry of the household; cooking and cleaning agents; spot and stain removal; ink; paint; textiles; foods.

or 4.—Such a combination of the above as shall, in the judgment of the teacher, best serve the needs of the class as a whole.

Let the work of this portion of the year be covered by the questions in part two of the entrance examination. In this way provision is made for the building up of a sound body of fundamental knowledge and also an opportunity is provided for acquiring a considerable fund of practical working knowledge by all students, but especially by those students who do not expect to continue their education beyond the high school. While the amount of required work for college admission would, by this plan, be much reduced, it seems to me that a real basis for a college course could thus be laid. Practically all of the fundamentals of chemistry are included in a thorough study of the non-metals. Any points of importance not thus included may well be deferred until the student has entered college. He can make his first acquaintance with them there.

It seems to me that the time has come when the rights of the ninety per cent must be more fully recognized. The time has come when it should be possible for teachers in all preparatory schools to give a course which shall not be so tied down to college requirements as to prevent instruction in the chemistry of the student's environment. The time has come when a course can be given in which both college requirement and the needs of the ninety per cent can be fairly met—a time when we need no longer deny to our great body of students such instruction in the chemistry of the local industries as shall enable them better to understand their environment and the means by which it can be controlled.

ABSTRACTS FOR THE WASHINGTON MEETING

The abstracts of the papers here listed have already been presented for reading before The Section of Chemical Education at the Washington Meeting, April 21st to 26th.

A New Covering for Laboratory Table Tops. B. S. HOPKINS. Rezilite, an inert mixture of bitumens and asbestos fibre with enough solvent to make a rubber-like plastic mass, has given satisfaction as a covering for laboratory tables. It is easily applied to almost any base, is not injured by either acids or bases, is resilient, fire-resisting, easily cleaned and long-lived. It shrinks slightly but repairs are easily and quickly made. The maximum cost of installation is about 40 cents per square foot, but the cost may be materially reduced.

Should the Electron Theory be Included in High School Chemistry? ROLAND B. HUTCHINS. The facts to be presented are the results of a questionnaire sent out to about three hundred Chemistry teachers in high schools in New England and to some of the larger high schools in other sections of the United States, wherein an attempt is made to obtain opinions of teachers concerning the desirability of presenting phases on the Electronic concept in high school Chemistry.

An account is made of the per cent of teachers who are explaining parts of the theory, together with their reasons for introducing it in secondary school chemistry. Methods that might be employed are suggested, paralleled with advice as to the better places for its entrance in class-room teaching. Advantages and disadvantages of giving the student a knowledge of the theory is considered from the standpoint of further college instruction and for general information. This implies as well, attitudes of certain colleges toward this instruction as reported by high school teachers.

Lastly some advantages that this theory exposes, by visualizing certain fundamental concepts of chemistry hitherto less plainly comprehended, is pointed out by teachers who have practiced the Electronic Theory in classes. No effort is made to propagate any part of the theory, but rather to indicate the present state of mind of a representative group of chemistry instructors relative to the advisability of using portions of the new sub-atomic ideas of matter for fundamental science teaching.

Course in Chemistry Being Developed at the Lorain High School, Lorain, Ohio. MARTIN V. MCGILL. Chemistry, chiefly an eleventh grade elective, is taught but one year. Classes average nearly thirty. Two forty-five minute periods are spent each day in actual class-room work. During first semester, theory work and underlying principles are stressed, covering text and laboratory work on acid forming elements. In the second semester, certain detailed and quantitative laboratory work and written reports are required of all students; class is divided into small sections for

quiz. Each student is also required to give about seven individual reports on assigned topics before the whole class. A chemistry club, membership in which is based on scholarship, furnishes good material for laboratory aides, which is a very important feature of this system. A usable library, with index and filing system, has been worked out.

Taking Note of the Mist in Chemistry. HORACE G. DEMING. This paper criticizes current efforts to popularize chemistry as being mere recitals of the wonders accomplished by chemistry, without any indication of how they are accomplished. Books telling what chemistry really is, in language that the common man can understand, simply do not exist.

College text-books consist too largely of meaningless synopses of the applications of chemistry to the industries, and disregard the fact that these are but passing illustrations of general principles, which stand immutable, while industries rise and fall. High school texts are too frequently but mutilated editions of those used in college. Beginners need a different system of instruction, not merely a briefer one.

Some suggestions are made concerning the organization of text-books along radically different lines. The effort to standardize high school courses in chemistry is deprecated, as tending to perpetuate a system of instruction which has proved inadequate, and as tending to make difficult the introduction of something new and better.

The High School Course in Chemistry. A. L. FERGUSON. The paper is an appeal for a return to or a continuance of the standards which have been so long maintained. The course in high school chemistry should be primarily disciplinary. Its principal objects should be to develop the ability to do, to observe accurately, to make logical inferences, to draw correct scientific conclusions as a result of observations, to express results in clear, correct English, to correlate facts and observations, and to think for themselves. The report of the National Committee on "Reorganization of Science in Secondary Schools," is severely criticized. It is emphasized that every opportunity should be taken to point out the every day and industrial applications of chemical principles, but that practical applications should be considered as a distinctly subsidiary phase of the course.

The Achievement of High School Students in Chemistry. S. R. POWERS. This paper reports results from the use of a large amount of test material with a large number of high school pupils who had studied chemistry in high school for one year. In all 350 different items were used. The paper reports the per cent of the possible responses to each item which were made correctly. Approximately 60 different high schools coöperated in the work. An analysis of the results from different schools furnish a measure of accomplishment under most and under least favorable conditions. The tests were also given to a group of students entering the university and who had studied chemistry in high school. A comparison

of the test scores with the subsequent achievement of the students gives an indication of the usefulness of tests like these for purposes of differentiating college students into rapid and slow moving groups.

Physical Chemistry for Undergraduates. G. H. CARTLEDGE. The undergraduate who devotes about one fourth of his time to chemistry cannot obtain a satisfactory knowledge of Physical Chemistry from the customary arrangement of courses. Since such students are unable to study the subject from the standpoint of Thermodynamics, it is argued that Physical Chemistry should be taught them as a tool to be used in Inorganic, Organic, and Analytical Chemistry. Certain portions of Physical Chemistry are intimately related to Inorganic and Analytical Chemistry; other portions apply more particularly to Organic Chemistry. It is proposed to divide the content of Physical Chemistry on this basis, and to teach each portion rather thoroughly in connection with the appropriate organic or inorganic courses, principally in the Junior year. This plan has been tested in the Johns Hopkins University with gratifying results.

Report of Committee on Teaching of Agriculture Chemistry. R. A. GORTNER, J. W. READ, AND H. R. KRAYBILL.

Report of Committee on Research for Teachers. W. H. CHAPIN, *Chairman.*

MEETING THE NEEDS OF THE FRESHMEN CHEMISTRY CLASS

ALBERT SALATHE, SWEET BRIAR COLLEGE, SWEET BRIAR, VA.

The question of sectioning General Chemistry so as to take care of those who have had high school chemistry, has often come up in ten years of teaching in small colleges. Experience on the Regents committee to make questions in Chemistry for the New York high schools, and the fact that I had my first Chemistry in a New York suburban school with an able teacher, early convinced me that the work given in an average city school can be of a high order of merit.

The fact that preparatory school Chemistry usually consists of but one year of work leads some students to boast of having had Chemistry before, quite as though it had been something they were exposed to and got over with, like the measles. The students in this women's college come mostly from city schools and are unusually well prepared. It is decidedly important not to have any of them feel that they are repeating high school work.

Obviously, as Alexander Smith used to say, "The high school Chemistry students learn *something*." It is reasonable that they should neither be required nor permitted to take Chemistry 1 in college with beginners. It has, however, been the rule to allow those who come prepared in Chemistry and who wish college science credit, to take Chemistry 1 with beginners

as well as to compel others, who may plan to major in the subject, to take the general course. The theory is, either that the college course is better than any preparatory school course, or, that the student will do better work because of his preparation in Chemistry. It is right to permit freshmen to take Chemistry 2, Qualitative Analysis, in place of Chemistry 1, if they can pass an examination in the first year work, satisfactory to the head of the department. College credit is not given for this examination.

In the small college, when the question of sectioning is brought up, the cost of instruction has to be considered; each teacher must be sufficiently occupied with teaching. In fact, research is expected and frequently required in addition to teaching. The instructor who gives four or five courses is quite too busy to have to teach Chemistry 1 in two sections, even though an able assistant takes care of the laboratory work.

The problem taxes the ingenuity of the college professor each year. It is far from settled. At the present time, I believe I am at least keeping up with the situation. In September, I find out, by direct inquiry what students have had high school Chemistry and where. This year there were only 25 in a class of 75. Then I put as many of them as possible in the same laboratory section. This helps in assigning laboratory experiments more advanced in character and especially more quantitative experiments and more qualitative unknowns. In the class it is understood that more is expected of these *advanced students*. They must use logarithms in their calculations, do extra outside reading, and, particularly, answer a large number of questions in the tests and final examinations. It is important to give college students a college course in Chemistry 1.

The procedure here outlined puts a little more work on the teacher, but the results make for better college Chemistry.

Local Activities and Opportunities

Missouri School of Mines: The Department of Chemistry of the Missouri School of Mines has inaugurated a new course in Petroleum Refining. The course will include the first two years of the regular chemical engineering curriculum together with the regularly required electrical engineering, power plants, geology and economics of the senior college. In the junior year, Organic and Physical chemistry are to be emphasized; especially in their application to the petroleum industry, while the senior year will include a thorough study of modern refinery practice.

The aim of the course is to train men in the fundamental principles of chemical engineering and to illustrate these in the actual refinery practice. The department has secured the coöperation of several large refineries who have furnished copious notes, data, blue prints, etc., and these have been supplemented by library acquisition of the best modern publications on the subject.

A special laboratory has been set aside for the petroleum refining course and is equipped with individual lockers and desks provided with air, water, gas, steam, electrical and drain outlets. The equipment includes the standard testing instruments of the American Petroleum Institute for distillation, flash and fire point, viscosity, gravity, color, etc. The plant equipment includes a still for crudes, a small cracking unit, a fractionating still, filter presses, agitators, tanks and accessories.

The University of Virginia announces the establishment of five teaching Fellowships carrying the annual stipend of Five Hundred Dollars, the special object of which is to enable properly qualified students to receive training in chemical research. Applications should be made on the forms furnished for the purpose. The courses completed and the grades made by the applicant should be recorded on the form by the registrar of the institution attended and the application should be sent to Professor Gardner L. Carter, Secretary of the Chemistry Faculty, University, Va., so as to reach him not later than April 1st.

California Institute of Technology: Four National Research Fellows in Chemistry are this year pursuing investigations at the Gates Chemical Laboratory of the California Institute of Technology. Dr. A. F. Benton (Princeton University) is continuing his work on the theory of heterogeneous catalysis with special reference to nickel and platinum. Dr. George Glocker (University of California) is studying the ionizing and resonance potentials of molecules. Dr. M. L. Huggins (University of California) is extending his investigations on electronic structure of crystals and on the crystal structure of organic compounds. Dr. P. S. Danner (University of California) is investigating the crystal structure of the mercurides of the alkalis and alkaline earths.

College Board Revising the Chemistry Syllabus: In April 1923 the College Entrance Examination Board appointed a Commission to revise the definition of the requirement in chemistry. This commission consists of Professor Percy T. Walden, Yale University, *Chairman*, Miss J. Cora Bennett, East High School, Cleveland, Ohio, Mr. Frank M. Greenlaw, Rogers High School, Newport, Rhode Island, Professor Annie L. Macleod, Vassar College, Poughkeepsie, New York, Mr. Henry S. Richards, High School, Yonkers, New York, Mr. W. Segerblom, The Phillips Exeter Academy, Exeter, N. H., Professor H. Monmouth Smith, Massachusetts Institute of Technology, Cambridge, Massachusetts, Professor Louisa S. Stevenson, Mt. Holyoke College, South Hadley, Mass., and Mr. Charles H. Stone, English High School, Boston, Mass. This Revision Commission met last spring and did some preliminary work on the Revision of the present College Board Syllabus. Since then considerable information bearing upon the work of the Commission has been collected and much constructive work has been done. A request has been published in various scientific periodicals asking chemistry teachers or any others who might have criticisms or constructive comments on the present syllabus to communicate such to the commission.

Roger Adams, acting director of the Chemistry Department, University of Illinois, is rapidly recovering from a severe illness.

BOOK REVIEW.

Study and Quiz Outline. By WILLIAM LLOYD EVANS, Ph.D., Professor of Chemistry, Ohio State University. Ginn and Company, Boston, New York, Chicago, London, Atlanta, Dallas, Columbus, San Francisco; 1923. x + 163 pp. 2 diagrams. 20.5 × 14.0 cm.

To the average student beginning the study of chemistry the determination of what is of first importance usually causes much more difficulty than the subject matter itself. Confronted by the extensive array of chemical facts contained in the average text book, he is apt to be dismayed and discouraged at the very beginning of the course. This state of mind can be very largely overcome if, at this time, some instruction is given in the best methods of study. To offer such instruction is one of the purposes of Dr. Evans' book and, to the reviewer's mind, it succeeds very well.

The book is based on MacPherson and Henderson's "A Course in General Chemistry," but with a few minor exceptions, it is quite applicable to any standard text. As its title implies, it is divided into two parts, study outlines and quiz questions. There are study outlines for about 25% of the chapters, but not for the others, so that the student will be encouraged to apply the outline method to them and thus acquire proficiency in its use.

There is a set of quiz questions for each chapter. There are four types,—standard quiz questions, numerous and well selected stoichiometrical problems, questions that cannot be answered by reference to some text but that require reasoning effort on the part of the student, and questions requiring the design of apparatus to investigate or illustrate various phenomena. The value of the two latter types in encouraging the use of reason rather than memory is quite evident. The quiz questions are fairly free from annoying ambiguity. Though there are quite a few "Discuss" questions, the extent of the discussion desired is usually clearly indicated The questions vary widely in the amount of detailed knowledge required to answer them, so that they may be suited to either quizzes or formal examinations. Equation writing is emphasized.

Two "production" diagrams are included. They are intended to show the relation of the more important compounds of an element to one another and to the parent element. The compounds of nitrogen and of sodium are offered as examples. The working out of such diagrams should be of great benefit to a student.

The only adverse criticism the reviewer can offer is that the modern electronic conception of oxidation-reduction reactions is stressed so lightly. Though the structure of matter and the electronic view of ionization are fully covered, electronic oxidation is scarcely touched upon. This is unfortunate since the latter furnishes the simplest and most generally satisfactory treatment of the subject. However this deficiency is one that is readily remedied. The reviewer feels that this is a most excellent book and one that any teacher can place with profit in the hands of his students.

University of Maryland,
College Park, Md. MALCOLM M. HARING